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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

BLEACHED KRAFT PULPS FROM MIXTURES OF PHILIPPINE HARDWOODS

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Summary

Bleached kraft pulps, with quality equal to or better than bleached kraft market pulps made from North American hardwoods, were made using three mixtures of 50 Philippine hardwoods.

Experimental

Wood Mixtures

The chips were made in a commercial-size, four-knife chipper from 50 species of bark-free Philippine hardwoods (table 1). The nominal length of the chips was five-eighths inch, and the fines and oversize material were removed prior to blending of individual species to obtain the three mixtures described in table 2. Mixture "A" contained an even distribution of all species, while mixture "B" was weighted with more of the high-density species and mixture "C" with the intermediate-density species. The weighted average specific gravity of the three mixtures was 0.505, 0.643, and 0.538, respectively.

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[1] Maintained in Madison, Wis., in cooperation with the University of Wisconsin.

Kraft Pulping

The kraft pulps of all three mixtures were made under the following conditions:

(1) 16 percent active alkali.

(2) 25 percent sulfidity.

(3) 4-to-1 water-to-wood ratio.

(4) 90 minutes to raise the temperature to 170° C.

(5) 90 minutes at 170° C.

Small-scale kraft digestions were made in a 0.8-cubic-foot stationary digester equipped with a liquor heating and circulating system. The results of yield and Kappa number determinations and black liquor analysis are given in AID Report No. 1, "Exploratory Kraft and NSSC Pulping of Mixtures of 50 Philippine Hardwoods."

Five pilot-scale digestions of mixture "A" were made in a 14-cubic-foot tumbling digester which was blown at the end of each digestion. The resulting pulps were washed, screened through a 0.012-inch slotted flat screen, and wet lapped prior to bleaching. The composite pulps had a Kappa number of 22.8.

Fifty-Gram CEHP and CEHD Bleaching Trials

Fifty-gram quantities (moisture-free basis) of kraft pulps made from the three wood mixtures were used in determining their responses to bleaching with CEHP and CEHD to about 87 percent brightness. Intermediate and final brightness, viscosity, and yield were determined for each pulp. The conditions and results of these bleaching trials are shown in table 3.

Five-Hundred-Gram CEDED Bleaching Trials

Five-hundred-gram quantities (moisture-free basis) of kraft pulps made from the three wood mixtures were used in determining their responses to bleaching with CEDED to the 90 percent brightness level. Initial and aged brightness, viscosity, and yield were determined for each pulp after the last stage of bleaching. The conditions and results of these bleaching trials are shown in table 4.

Pilot-Scale CEH and CEDED Bleaching Trials

One hundred and thirty pounds (moisture-free basis) of the composite pilot-scale kraft pulps having a Kappa number of 22.8 were semibleached to a brightness of 76.4 percent using CEH. This pulp was used in the furnishes of the newsprint paper machine trials reported in AID Report No. 2, "Newsprint From Mixtures of Philippine Hardwoods."

Two 100-pound (moisture-free basis) pilot-scale bleaches were made using CEDED. The first produced a bleached pulp with a brightness of 86.7 percent, which was used in the furnishes of the tablet, tissue, and toweling paper machine trials reported in AID Report No. 3, "Tablet Papers From Mixtures of Philippine Hardwoods," and AID Report No. 4, "Tissue and Toweling Papers From Mixtures of Philippine Hardwoods." The second produced a bleached pulp with a brightness of 88.8 percent, which was dried on the paper machine in order to provide samples of a market-type pulpsheet (bleach No. 6799 attached).

The conditions and results of these pilot-scale bleaching trials are shown in table 5. Because our pilot-scale bleach plant is not resistant to the corrosiveness of chlorine dioxide, the chlorine dioxide

stages were made in a glass-lined stock tank at a consistency of 3 to 4 percent rather than the usual consistency of 10 percent or higher.

Results

Response to Bleaching

The 50-gram CEHP and CEHD bleaching results show that the kraft pulps from mixture "A" and "C" respond similarly (table 3). The kraft pulp from mixture "B" appears to be more difficult to bleach as evidenced by higher chemical consumption and lower brightness values after the hypochlorite stage and after either the peroxide or the dioxide stage. As expected, the viscosity of all three pulps was low after the hypochlorite stage, with the pulps from mixtures "A" and "C" having values of about 10.5 centipoises, while the pulp from mixture "B" had a value of 13.3 centipoises. Peroxide lowered the viscosity of all three pulps even further to about 7.7 centipoises, while chlorine dioxide retained essentially the same viscosity found after the hypochlorite stage. The yields of bleached pulp after either peroxide or dioxide were about 94 percent.

The 500-gram CEDED bleaching results show only slight differences between the various pulps in their response to bleaching. All of the pulps were bleached to the 90 percent brightness level, and all lost about 4 percentage points of brightness upon aging for 1 hour in an oven at 105° C. As expected, the viscosity of the CEDED bleached pulps was considerably higher than that of the pulps bleached with a hypochlorite stage.

Use of low consistency during the chlorine dioxide stages of the pilot-scale bleaches did not appear to cause any detrimental effects on the final pulp quality. However, slightly more chlorine dioxide was applied during the pilot-scale bleaches than during the 500-gram bleaches in order to compensate for the atmospheric losses from the open stock tank used for the chlorine dioxide stages.

The viscosity of the pilot-scale CEH bleached pulp was 8.7 centipoises, while the 50-gram CEH bleached pulp had a viscosity of 10.2 centipoises. This same trend was found with the pilot-scale and 500-gram CEDED bleached pulps which had viscosities of 11.6 and 21.1 centipoises, respectively. These differences in viscosity may have been partly caused by the differences in the Kappa numbers of the unbleached pulps which were 22.8 for the pilot-scale pulp and 29.6 for the small-scale pulp. These losses in viscosity are also reflected in the handsheet properties of both the CEH and CEDED pilot-scale pulps (tables 6 and 7).

Handsheet Properties

Handsheet properties of both the unbleached and the 500-gram CEDED bleached pulps are given in table 6. As reported earlier in AID Report No. 1, there are only small differences between the unbleached pulps made from the three wood mixtures. Similarly, the differences between the corresponding unbleached and the 500-gram CEDED bleached pulps are also small.

As shown in table 7, the unbleached pilot-scale pulp from mixture "A" with a Kappa number of 22.8 has about 10 percent lower tearing resistance

than the small-scale pulp also made from mixture "A" but with a Kappa number of 29.6. However, the bursting and tensile strengths of these two unbleached pulps appear to be about the same.

The pulps from both the CEH and CEDED pilot-scale bleaches lost 10 to 20 percent of their original bursting and tensile strengths. There was only a slight loss in tearing resistance of the CEH bleached pulp, while the tearing resistance of the CEDED bleached pulp actually increased about 10 percent. This increase in tearing resistance was lost, however, when this pulp was dried on the paper machine.

Even with the above losses, the dried CEDED bleached pulp was equal to or better than the two bleached kraft market pulps made from North American hardwoods grown in different areas.

Conclusions

(1) Bleachable grades of kraft pulp can be made from the three mixtures of Philippine hardwoods which can be semibleached with a CEH sequence or fully bleached with a CEDED sequence.

(2) The strength properties of the bleached kraft pulps made from all three mixtures were equal to or better than those of bleached kraft market pulps made from North American hardwoods.

Table 1.--Names and specific gravities of the Philippine hardwoods

No.	Common name	Botanical name	Specific gravity
1	Tangisang-bayauak	Ficus variegata	0.236
2	Binuang	Octomeles sumatrana	.242
3	Kapok	Ceiba pentandra	.244
4	Balilang-uak	Meliosma macrophylla	.260
5	Rarang	Erythrina subumbrans	.264
6	Kaitana	Zanthoxylum rhetsa	.296
7	Ilang-ilang	Cananga odorata	.308
8	Gubas	Endospermum peltatum	.316
9	Dita	Alstonia scholaris	.316
10	Anabiong	Trema orientalis	.319
11	Hamindang	Macaranga bicolor	.324
12	Balanti	Homalanthus populneus	.356
13	Mayapis	Shorea squamata	.366
14	Matang-arau	Melicope triphylla	.381
15	Malasantol	Sandoricum vidalii	.394
16	White lauan	Pentacme contorta	.401
17	Tulo	Alphitonia philippinensis	.422
18	Tangile	Shorea polysperma	.429
19	Pahutan	Mangifera altissima	.435
20	Apanit	Mastixia philippinensis	.447
21	Lago	Pygeum vulgare	.451
22	Antipolo	Artocarpus blancoi	.469
23	Bagtikan	Parashorea plicata	.478
24	Sakat	Terminalia nitens	.485
25	Red lauan	Shorea negrosensis	.510
26	Itangan	Weinmannia luzoniensis	.526
27	Piling-liitan	Canarium luzonicum	.549
28	Palosapis	Anisoptera thurifera	.554
29	Lomarau	Swintonia foxworthyi	.559
30	Malabetis	Madhuca oblongifolia	.560

Table 1.--Names and specific gravities of the Philippine hardwoods--Con.

No.	Common name	Botanical name	Specific gravity
31	Dangkalan	Calophyllum obliquinervium	0.568
32	Panau	Dipterocarpus gracilis	.576
33	Katmon	Dillenia philippinensis	.592
34	Batitinan	Lagerstroemia piriformis	.597
35	Katong-lakihan	Amoora macrophylla	.608
36	Narig	Vatica mangachapoi	.618
37	Miau	Dysoxylum euphlebium	.623
38	Apitong	Dipterocarpus grandiflorus	.623
39	Bok-bok	Xanthophyllum excelsum	.639
40	Kamatog	Erythrophloeum densiflorum	.650
41	Dalingdingan	Hopea foxworthyi	.667
42	Katilma	Diospyros nitida	.679
43	Yakal	Shorea astylosa	.718
44	Kamagong	Diospyros philippinensis	.720
45	Katong-matsin	Chisocheton pentandrus	.725
46	Manaring	Lithocarpus soleriana	.736
47	Ipil-ipil	Leucaena leucocephala	.737
48	Bolong-eta	Diospyros pilosanthera	.743
49	Makaasim	Syzygium nitidum	.778
50	Alupag-amo	Litchi philippinensis	.793

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Table 2.--Composition of three chip mixtures of 50 Philippine hardwoods

Species[1]	Specific gravity range	Mixture composition[2]		
		A	B	C
		Pct	Pct	Pct
1 - 6	0.236 - 0.296	16.67	2	4
7 - 15	.308 - .394	16.67	4	8
16 - 24	.401 - .485	16.67	9	20
25 - 34	.510 - .597	16.67	15	40
35 - 42	.608 - .679	16.67	20	20
43 - 50	.718 - .793	16.67	50	8

[1] See Table 1 for names of the individual species.

[2] Moisture-free wood basis.

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Table 3.--50-gram CEHP and CEHD bleaching[1] of kraft pulps made from 3 mixtures of Philippine hardwoods

Stage No.	Chip mixture	Kappa No.	Bleach No.	Chemical: Name	Chemical: Amount applied	Chemical: Amount consumed	pH: Initial	pH: Final	Brightness	Viscosity	Yield
					Pct	Pct			Pct	cP	Pct
1	A	29.6	6789	Chlorine	7.0	5.2	2.5	2.4	--	--	--
1	B	29.1	6790	....do....	6.8	5.7	2.5	2.4	--	--	--
1	C	27.8	6791	....do....	6.5	5.5	2.6	2.5	--	--	--
2	A	--	6789	Sodium hydroxide	2.0	--	11.8	11.4	--	--	--
2	B	--	6790	....do....	2.0	--	11.8	11.4	--	--	--
2	C	--	6791	....do....	2.0	--	11.9	11.5	--	--	--
3	A	--	6789	Sodium hypochlorite	2.0	1.5	10.8	9.5	81.3	10.2	--
3	B	--	6790	....do....	2.0	1.6	11.0	9.5	77.1	13.3	--
3	C	--	6791	....do....	2.0	1.3	10.9	9.4	80.0	10.7	--
4	A	--	6789	Hydrogen peroxide	.36	.26	11.0	10.4	86.3	7.7	93.1
4	B	--	6790	....do....	.48	.48	10.9	10.2	82.9	7.7	94.0
4	C	--	6791	....do....	.48	.48	11.0	10.5	84.4	7.4	93.5
4A	A	--	6789A	Chlorine dioxide	.28	.28	--	6.8	87.6	10.1	94.3
4A	B	--	6790A	....do....	.38	.38	--	6.7	83.6	11.2	94.9
4A	C	--	6791A	....do....	.38	.38	--	6.4	87.2	10.6	94.1

[1] Constant conditions used for temperature, consistence, and time were as follows: Stage 1--25° C., 2 pct, and 60 min; stage 2--70° C., 10 pct, and 60 min; stage 3--37° C., 10 pct, and 240 min; stages 4 and 4A--70° C., 10 pct, and 120 min.

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Stage No.	Chip mixture	Kappa No.	Bleach No.	Chemical: Name	Chemical: Amount applied	Chemical: Amount consumed	pH: Initial	pH: Final	Brightness: Initial	Brightness: After aging[2]	Viscosity	Yield
					Pct	Pct			Pct	Pct	cP	Pct
1	A	29.6	6800	Chlorine	6.8	6.7	2.7	2.5	--	--	--	--
1	B	29.1	6801	.....do.....	6.8	6.7	2.8	2.7	--	--	--	--
1	C	27.8	6802	.....do.....	6.2	6.1	2.6	2.4	--	--	--	--
2	A	--	6800	Sodium hydroxide	2.0	--	11.7	11.4	--	--	--	--
2	B	--	6801	.....do.....	2.0	--	11.6	11.3	--	--	--	--
2	C	--	6802	.....do.....	2.0	--	11.5	11.3	--	--	--	--
3	A	--	6800	Chlorine dioxide	.76	.76	--	3.8	--	--	--	--
3	B	--	6801	.....do.....	.76	.76	--	4.0	--	--	--	--
3	C	--	6802	.....do.....	.76	.76	--	3.9	--	--	--	--
4	A	--	6800	Sodium hydroxide	1.0	--	11.5	11.3	--	--	--	--
4	B	--	6801	.....do.....	1.0	--	11.6	11.4	--	--	--	--
4	C	--	6802	.....do.....	1.0	--	11.4	11.3	--	--	--	--
5	A	--	6800	Chlorine dioxide	.28	.28	--	6.5	89.1	84.6	21.1	93.0
5	B	--	6801	.....do.....	.28	.28	--	6.5	89.2	84.7	19.1	93.0
5	C	--	6802	.....do.....	.28	.28	--	6.5	90.0	86.5	18.3	92.8

[1] Constant conditions used for temperature, consistence, and time were as follows: Stage 1--25° C., 2 pct, and 60 min; stage 2--70° C., 10 pct, and 60 min; stages 3 and 5--70° C., 10 pct, and 240 min; stage 4--50° C., 10 pct, and 60 min.

[2] For 1 hr in an oven at 105° C.

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Stage No.	Bleach No.	Chemical: Name	Chemical: Amount applied	Chemical: Amount consumed	Temperature	Consistence	Time	pH: Initial	pH: Final	Brightness	Viscosity
			Pct	Pct	°C	Pct	Min			Pct	cP
1	6793	Chlorine	6.3	6.2	21	2.7	60	3.5	3.2	--	--
1	6797	.....do.....	5.5	--	25	1.9	60	2.8	2.7	--	--
1	6799	.....do.....	5.5	--	25	2.4	60	2.6	2.4	--	--
2	6793	Sodium hydroxide	2.0	--	70	10.2	60	11.4	11.2	--	--
2	6797	.....do.....	2.0	--	71	10.6	60	11.4	11.3	--	--
2	6799	.....do.....	2.0	--	72	10.2	60	11.3	11.0	--	--
3	6793	Sodium hypochlorite	1.8	1.6	38	11.0	240	10.6	9.4	76.4	8.7
3	6797	Chlorine dioxide	.76	.76	68	4.0	120	--	6.7	--	--
3	6799	.....do.....	.76	.76	70	3.0	90	--	6.5	81.3	--
4	6797	Sodium hydroxide	1.0	--	50	10.9	60	11.8	11.6	--	--
4	6799	.....do.....	1.0	--	50	10.6	60	11.8	11.7	--	--
5	6797	Chlorine dioxide	.38	.38	70	3.6	180	--	6.5	86.7	--
5	6799	.....do.....	.38	.38	70	3.0	90	--	6.7	88.8	11.6

[1]Blend of 5 pilot-scale digestions with a composite Kappa number of 22.8.

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Table 6.--Handsheet properties of unbleached and 500-gram CEDED bleached kraft pulps made from 3 mixtures of Philippine hardwoods

Pulp type	Beating time	Freeness (Canadian Standard)	Burst factor	Tear factor	Breaking length	Apparent density
	Min	Ml			Km	G/cm^3
MIXTURE A						
Unbleached	0	645	22.9	133.6	5.9	0.51
Do.	18	550	52.5	136.5	9.3	.59
Do.	48	350	72.5	131.0	11.8	.67
Bleached	0	665	23.7	107.2	4.6	.59
Do.	10	550	56.0	140.0	8.8	.65
Do.	27	350	76.5	133.0	10.9	.69
MIXTURE B						
Unbleached	0	675	14.7	88.5	4.5	.46
Do.	25	550	46.0	134.0	8.7	.57
Do.	55	350	66.5	139.0	10.8	.65
Bleached	0	680	18.4	84.2	4.1	.50
Do.	11	550	50.5	149.5	8.3	.62
Do.	27	350	69.5	143.5	10.3	.68
MIXTURE C						
Unbleached	0	675	21.5	114.8	6.0	.52
Do.	33	550	57.5	139.0	9.9	.61
Do.	57	350	73.0	136.0	11.5	.66
Bleached	0	680	20.5	134.6	4.5	.57
Do.	11	550	56.0	135.0	9.1	.65
Do.	28	350	72.5	131.0	11.3	.70

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